MASSACHUSETTS FLOOD PLAIN MANAGEMENT SERVICES

# TEN MILE RIVER
# INITIAL FLOODING ASSESSMENT
# ATTLEBORO, NORTH ATTLEBORO, & PLAINVILLE, MASSACHUSETTS

April 2002

US Army Corps
of Engineers

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At the request of the communities of Attleboro, North Attleboro, and Plainville, Massachusetts, the New England District, Corps of Engineers performed an initial assessment of flooding problems along the Ten Mile River. The Corps examined priority sites identified by the communities, but concluded that a more in-depth evaluation of the watershed is required to provide measurable assessments of benefits from possible actions to reduce flood damages. This in-depth evaluation will require collecting survey data on the river and updating the computer model used in the Federal Emergency Management Agency's, Flood Insurance Studies (FIS) for these communities during the late 1970's. This report summarizes the initial Corps assessment and outlines the required additional studies.

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# TEN MILE RIVER
# INITIAL FLOODING ASSESSMENT

## I. Summary

At the request of the communities of Attleboro, North Attleboro, and Plainville, the Corps performed an initial assessment of flooding problems along the Ten Mile River. The Corps examined priority sites identified by the communities, but concluded that a more in-depth evaluation of the watershed is required to provide measurable assessments of benefits from possible actions to reduce flood damages. This in-depth evaluation will require collecting survey data on the river and updating the computer model used in the Federal Emergency Management Agency's, Flood Insurance Studies (FIS) for these communities during the late 1970's. This report summarizes the initial Corps assessment and outlines the required additional studies.

## II. Introduction

The Ten Mile River in Plainville, North Attleboro, and Attleboro has seen persistent flooding over the years. In the fall of 1998 these communities, in conjunction with the Ten Mile River Watershed Association, requested that the U.S. Army Corps of Engineers, New England District assess the situation. The Corps, under the authority of its Flood Plain Management Services Program (Section 206, Flood Control Act of 1960), began an investigation of the river's flooding problems and potential solutions.

## III. Initial Flooding Assessment

The Corps initially looked into the possibility of preparing a flood routing model of the river using existing flow and cross-section information. A flood routing model allows for the analysis of the hydraulic characteristics of the river and an estimate of water surface elevations for selected flood events. Such a study would analyze alternatives such as channel widening or deepening, modifications to bridges and culverts, and modifications to or removal of existing dams. Examination of the existing flow and cross section data (primarily bridge and culvert crossings) from the FIS for North Attleboro (1979) and Attleboro (1978) against existing field conditions determined that extensive new survey data would be needed to establish a flood routing model. Unfortunately, the cost to obtain this survey data in North Attleboro and Attleboro alone exceeded the normal level of effort the Corps can typically devote to these technical assistance investigations.

Therefore, the communities and the Corps (June 2000) decided to re-focus the efforts of the study on several priority sites for flood mitigation: providing additional flood storage at Falls Pond and two wetland restoration areas in North Attleboro, diverting flood flows to Manchester Reservoir, and the manipulation of Dodgeville Dam in Attleboro. Using existing data, the Corps was to conduct assessments of each site's value in reducing flood levels. If data was lacking, the Corps was to provide a list of the additional studies and associated costs needed to conduct a detailed analysis. Existing information was found to be very limited and only qualitative assessments of each site were conducted. The results of those assessments are shown in the attached Technical Reports and are summarized below.

### A. Falls Pond and Other Flood Storage Potential

Falls Pond appears to have some excess storage capacity to help reduce flooding in North Attleboro. However, that storage use may conflict with the recreational use of the pond at certain times of the year. There was not enough information available on the two upstream wetland areas to make any sort of definitive determination regarding their flood reduction value. Assuming they were restored and could hold an average of four feet of water, it is estimated they would provide about 0.57 inches of runoff storage (a relatively small amount in comparison to the entire drainage area).

### B. Manchester Pond Reservoir

Manchester Pond Reservoir has sufficient excess storage capacity at certain times of the year such that a diversion from Falls Pond could reduce flooding in North Attleboro and Attleboro by keeping the level of Falls Pond lower. However, the flood control storage at Manchester Pond Reservoir would be seasonal, unreliable, and of minimal value by itself unless the reservoir was operated for flood control purposes, at the expense of water supply. However, this would most likely result in a negative water quality impact on the existing water supply.

### C. Dodgeville Dam

While lowering the pool at Dodgeville Dam would not have much effect, increasing the discharge through the dam might have significant effects on reducing upstream flooding. Ways to accomplish this range from clearing the flashboards and their supports from the spillway, to reactivating and enlarging the outlet gates, to removing the dam completely.

### D. Additional Analyses

As reported at the most recent meeting between the Corps, the State, and the communities (February 2002), additional analyses are needed to fully evaluate each of the flood reduction measures listed. It was also decided that flow diversion to Manchester Reservoir was not a feasible alternative and should not be included in any further study. We recommend a tiered approach that will first require updating the survey data for various river crossings from Bridge Street (Attleboro) to Wetherells Pond (Plainville). The Corps will then create a backwater model for the river, using existing flow information from the FIS, to evaluate the various flood reduction measures that the communities wants investigated. This study will utilize existing topographic mapping that was available. The cost of this initial study would be about $120,000.

| | |
|---|---|
| Surveyed Cross Sections | $55,000 |
| Initial Backwater Analysis | 50,000 |
| Management | 15,000 |
| | $120,000 |

If the existing flow information for the watershed has changed significantly (and this is difficult to determine as there is no gage data available along the Ten Mile River), then a new flow frequency analysis would also need to be performed. This is estimated to cost about $50,000 more and would include the re-running of the backwater analysis.

| | |
|---|---|
| Surveyed Cross Sections | $55,000 |
| Initial Backwater Analysis | 50,000 |
| Flow Frequency Analysis | 50,000 |
| Management | 20,000 |
| | $175,000 |

As stated at the meeting, this type of analysis can be done through the Corps Planning Assistance to States (PAS) program. The PAS program is a technical assistance program that allows the Corps to share in the costs (50% Federal/50% non-Federal) of any type of water resource related investigation. If the larger effort is undertaken, the work may need to be phased over several fiscal years.

# TECHNICAL REPORT – 1

# FALLS POND AND OTHER FLOOD STORAGE POTENTIAL

# FALLS POND AND OTHER FLOOD STORAGE POTENTIAL REPORT

I. Summary.

The Town of North Attleboro requested that the Corps of Engineers investigate the benefits of creating possible flood storage areas by utilizing two upstream wetland areas located in North Attleboro. This preliminary study found that Falls Pond in combination with the wetland areas has sufficient excess storage capacity at certain times of the year to potentially reduce flood levels in North Attleboro, and flood discharges in Attleboro. However, the determination of the exact amount of this improvement will require additional study.

II. Introduction.

A. Background. Flooding from the Tenmile River in Attleboro and North Attleboro centers is a persistent problem. Flood flows into Falls Pond backup into North Attleboro center, and high discharges from Falls Pond, combined with flows from intervening drainage areas, flood Attleboro center. North Attleboro and Attleboro requested the Corps to perform cursory evaluations under the Flood Plain Management Services program of using seasonal excess capacity in Manchester Pond Reservoir to store flood flows to possibly reduce flooding in both city centers and increase water supply, and to evaluate the flood storage potential of two wetland areas upstream of Falls Pond. The use of Manchester Pond Reservoir for seasonal excess flood storage by diverting flood flows from Falls Pond was reviewed and summarized in the Manchester Pond Reservoir report. This report will take a look at two distinct wetland areas upstream of Falls Pond, as well as Falls Pond itself, for increasing flood storage and reducing flood stages and flows in both communities.

B. Location. Falls Pond is located in south central North Attleboro, Massachusetts and is bounded by Washington Street to the west and Interstate 295 to the south. Falls Pond Dam impounds water from the Tenmile River and is located at the northeast corner of the pond. The two potential wetland flood storage areas are located upstream of Falls Pond on the Tenmile River are described as follows: the larger wetland is approximately 1000 feet upstream of Falls Pond bounded by Washington Street on the west and East Washington Street on the east, and the smaller wetland is approximately 1.5 miles upstream of Falls Pond where Washington and East Washington Streets merge. Refer to Figure 1 for locations of Falls Pond and the upstream wetland areas.

C. Available Data. Available data on Falls Pond Dam include:

1. April 1979 Phase I Inspection Report prepared under the National Dam Inspection Program.

2. A December 1995 engineering report for improvements to Falls Pond Dam prepared by Keyes Associates for the town of North Attleboro.

3. Contract documents for renovations to Whiting Pond Dam and Falls Pond Dam prepared by Keyes Associates in July 1996 for the town of North Attleboro.

There is no detailed information on the potential wetland flood storage areas except for the USGS Attleboro, Mass.-R.I. Quadrangle and field notes and photos from a field reconnaissance trip conducted on December 12, 2000 by the Corps of Engineers.

III. Falls Pond Dam.

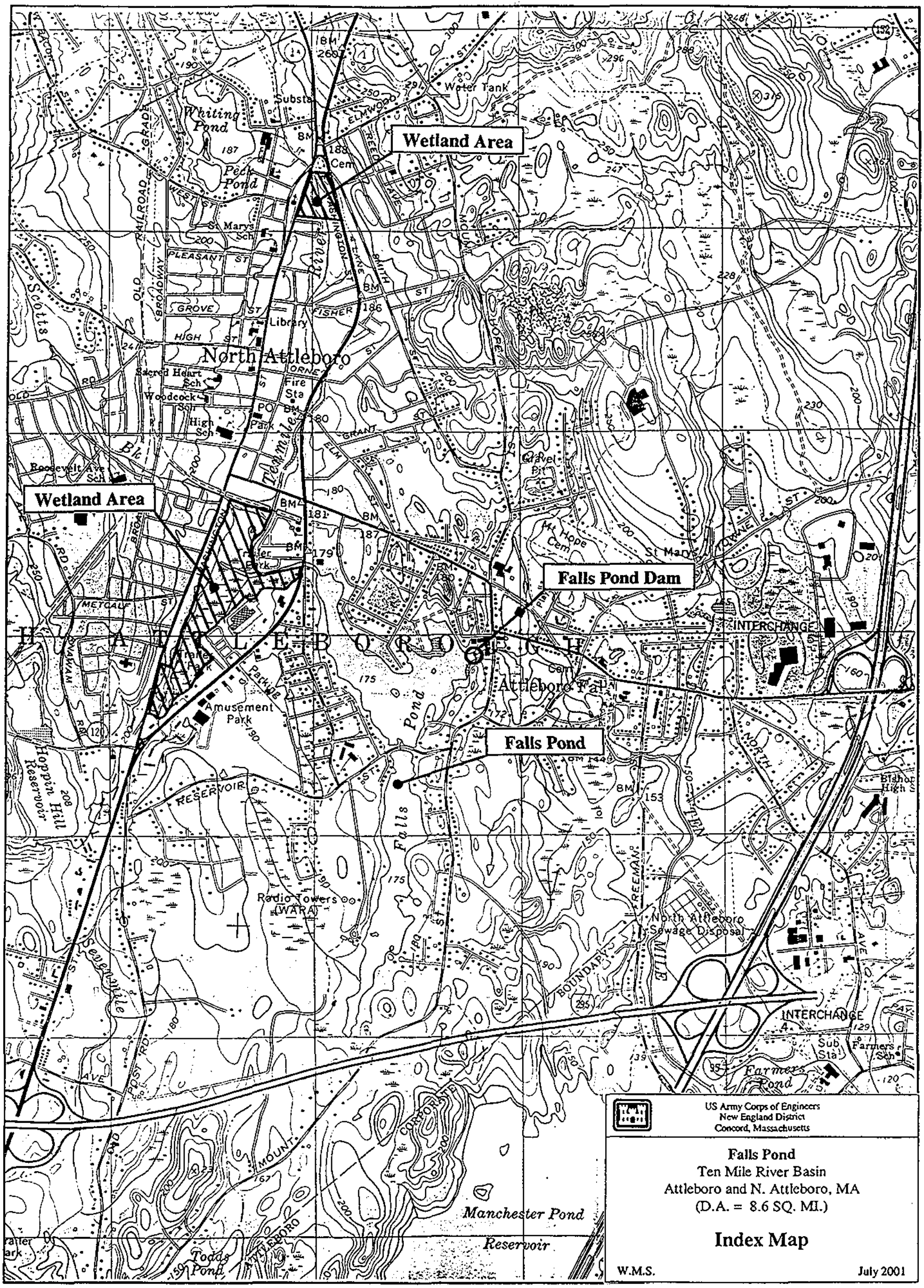
A. Features. Falls Pond Dam is an earthfill dam approximately 19 feet high and 185 feet long with a top width of 25 feet. The dam with a crest elevation of 176.7 ft. National Geodetic Vertical Datum (NGVD) consists of a main spillway with tainter gates, and an auxiliary spillway. The main spillway consists of three 15-foot long bays separated by 3-foot wide concrete piers, which support a concrete and steel access walkway. The main spillway is a broad crested weir with a vertical upstream wall and a downstream chute 9.5 feet high with a crest elevation of 167.5 ft. NGVD. Each of the 15-foot bays is equipped with an automatically operating tainter gate with the operating mechanism located on the walkway. All of the automatic operating mechanisms are no longer operating and the gates are opened and closed manually by using the hand wheels on the gate operators. The auxiliary spillway is 28 feet long with a crest elevation of 173.5 ft. NGVD.

Falls Pond is divided into two ponds by the Reservoir Street causeway. A concrete outlet structure and a conduit connect the two ponds. The outlet structure has two sets of stop logs that control flow between the ponds. The drainage area for Falls Pond is approximately 5,517 acres (8.6 square miles) and is located in the towns of Plainville and North Attleboro, Massachusetts. When the pond is filled to create a recreation pool (spillway crest elevation 173.5 ft. NGVD) the pond has an area of 92 acres.

B. Discharge Capacity. With the pool at the top of dam, elevation 176.7 ft. NGVD, and the gates fully open, the maximum discharge capacity of the spillways is about 3,880 cfs. With the tainter gates closed and the pond level at 176.7 ft. NGVD, the spillways can discharge approximately 1,400 cfs.

C. Operation. Pool levels vary seasonally for recreational purposes. The tainter gates are closed in April and opened in October. The summer recreation pool is at elevation 173.5 ft. NGVD (gates closed), and the winter pool is at elevation 167.5 ft. NGVD (gates open). There is no low-level outlet at the dam.

D. Reservoir Storage. The Phase I inspection report gives the total storage of Falls Pond with the gates fully closed and the pool at elevation 173.5 ft. NGVD as 0.0 acre-feet, and the storage with the pool at the top of the dam as approximately 300 acre-feet. The Keyes Associates report states the storage of Falls Pond with the pool at the top of dam is 425 acre-feet. Using the stage-storage curve in the Phase I inspection report, we found that for every foot of pool rise the storage increases approximately by 100 acre-feet. Storage below elevation 173.5 ft. NGVD, spillway crest with gates closed, was estimated by assuming that the 100 acre per foot drop in surface area continued to elevation 167.5 ft. NGVD, spillway crest with gates open.



Wetland Area
Wetland Area
Falls Pond Dam
Falls Pond
North Attleboro
Attleboro Falls
Whiting Pond
Peck Pond
Hoppin Hill Reservoir
Radio Towers (WARA)
Amusement Park
North Attleboro Sewage Disposal
INTERCHANGE
Farmers Pond
Manchester Pond
Reservoir
Todds Pond
US Army Corps of Engineers
New England District
Concord, Massachusetts
Falls Pond
Ten Mile River Basin
Attleboro and N. Attleboro, MA
(D.A. = 8.6 SQ. MI.)
Index Map
W.M.S.
July 2001


FIGURE 1

The two reports discussed above have contradicting values for storage at several elevations, therefore the stage-storage relationship for Falls Pond should be better defined to provide a more accurate estimate of flood storage capabilities of Falls Pond. Assuming that the storage at elevation 167.5 ft. NGVD is 0.0 acre-feet, then the available storage in Falls Pond from the winter pool to the summer pool elevation of 173.5 ft. NGVD is approximately 600 acre-feet.

IV. Hydrologic/Hydraulic Analysis.

A hydrologic/hydraulic analysis was conducted by Keyes Associates using different storm events and routing them through Falls Pond with different starting pool levels and gate openings. More detailed information on the analysis can be found in the Keyes Associates, "Improvements to Falls Pond Engineering Report" dated December 1995. Two of the scenarios that were modeled by Keyes Associates compare the response of Falls Pond for several different storm events where the gates are closed and the starting pool level is 173.5 ft. NGVD, and with one gate fully open and the starting pool level at 167.5 ft. NGVD. Routing the 100-year storm for the first scenario produces a pool elevation of 175.71 ft. NGVD that is close to the FEMA 100-year elevation of 176.0 ft. NGVD. The second scenario was used to simulate the additional spillway capacity of the gates to prepare for a major runoff event. Routing a 100-year storm with one gate fully open from the start of the storm and Falls Pond at an initial pool elevation of 167.5 ft. NGVD produces a 100-year flood elevation of 173.45 ft. NGVD. The spillways and the dam will have sufficient freeboard from major storm events up to the 100-year storm. Table 1 (taken from the Keyes Assoc. Engineering Report) shows the Falls Pond headwater elevation for several different storm events for the two scenarios explained above.

**Table 1**:
Falls Pond Headwater Elevations
(Taken from the Keyes Assoc. Engineering Report, dated Dec. 1995)

| **Storm Frequency** (Years) | **Scenario*** | | | |
|---|---|---|---|---|
| | Run No. 4 | | Run No. 5 | |
| | Discharge (cfs) | Pool Elevation (ft. NGVD) | Discharge (cfs) | Pool Elevation (ft. NGVD) |
| 2 | 218 | 174.26 | 158 | 169.71 |
| 10 | 432 | 175.00 | 348 | 171.22 |
| 25 | 549 | 175.23 | 454 | 172.02 |
| 50 | 661 | 175.45 | 564 | 172.71 |
| 100 | 791 | 175.71 | 684 | 173.45 |
| 500 | 1161 | 176.34 | 1133 | 174.77 |

* Scenarios:

Run No. 4 - 48-hour model with no gates open and initial pool stage at 173.5 ft. NGVD.
Run No. 5 - 48-hour model with one gate open and initial pool stage at 167.5 ft. NGVD.

The analysis conducted by Keyes Associates shows that by using the available storage between elevations 167.5 and 173.5 ft. NGVD, Falls Pond has the potential to reduce peak flood levels through flood operation procedures. A more detailed hydrologic/hydraulic analysis needs to be conducted to better determine the extent of flood protection Falls Pond can provide and its effects on flood levels upstream in the Town of North Attleboro.

V. Wetland Flood Storage Areas.

The larger wetland is approximately 1000 feet upstream of Falls Pond bounded by Washington Street on the west and East Washington Street on the east, and the smaller wetland is approximately 1.5 miles upstream from Falls Pond where Washington and East Washington Streets merge (Refer to Figure 1). Both of these wetlands would need to be cleared and dredged to take advantage of any potential flood storage. The larger wetland has a surface area of approximately 56 acres, and the smaller wetland has a surface area of approximately 10 acres. From field observations, it appears that both wetlands could potentially store up to 4 feet of floodwater. The actual storage potential of these wetlands would need to be defined through detailed survey, and a backwater analysis of the Ten Mile River. If the wetlands could store up to 4 feet of water, they could provide approximately 0.57" of runoff storage over the entire 8.6 sq. mi. drainage area. A runoff volume of .57" is minimal and could occur in the beginning of a storm resulting in the filling of the wetlands before the peak of the storm is experienced.

VI. Additional Studies.

A. Introduction. Extensive hydraulic and hydrologic studies are required to determine the flood damage reduction potential of Falls Pond and the identified wetland areas. Such a study should first look at the existing conditions and how that compares to the Flood Insurance Studies and known storm events that have caused flooding. Several alternatives need to be modeled to determine the flood damage reduction potential of each. Some possible alternatives are the use of the difference in storage between the summer and winter pools at Falls Pond, dredging the wetland areas for additional flood storage, and selective dredging of the river channel in flood prone areas. However, before undertaking this analysis, an extensive survey of the road crossings, restrictions of the river channel, the wetland areas, and the dam at Falls Pond should be conducted. A detailed survey will help to better model the existing conditions and show how the watershed is reacting to certain storm events.

B. Studies. The initial evaluation of Tenmile River should be conducted using a backwater program, such as HEC-RAS, to compute water levels under existing conditions and the affects of the alternatives suggested. A backwater analysis to analyze the flood reduction potential of the two wetlands and Falls Pond could start just downstream of the dam at Falls Pond and continue to the outlet of Wetherell's Pond, upstream of North Attleboro center. There are over a dozen bridges or other channel restrictions that would have to be surveyed – if recent data is not available – for input data to the backwater computations. Existing flow data will be used to model existing conditions and to evaluate the alternatives to determine their effect on flood levels in North Attleboro. Based on estimates received for similar survey work, the cost to hire a private firm to do this work might be around $25,000. The cost of hiring a private firm to perform the backwater analysis might be another $20,000.

If the flood storage at Falls Pond and the wetland areas were found to have a significant effect on the 10-year flood at North Attleboro center, then studies could proceed to the next phase. The ten-year flood is used as a minimal standard, with the idea that an action that doesn't have much effect on at least the 10-year levels (more frequent flooding) is not worth pursuing. The next phase will require a flood-routing analysis to determine the effects of the storage at Falls Pond, and the wetlands on flood levels in North Attleboro center, and reduced discharges in Attleboro. Finally, the flows in the FIS might need to be updated through a flood-frequency analysis to allow an accurate estimate of how often North Attleboro center is being damaged due to flooding.

Flood-routing analyses could probably be performed with existing mapping supplemented with survey data collected for the backwater analyses. The cost of hiring a firm to perform the computer program runs might be $15,000. An updated flood frequency analysis would be very useful for determining how often benefits would accrue from flow reductions attributed to the storage of these wetland areas, and Falls Pond. If a new flow-frequency analysis was needed, it could require an in-depth review of current land use, and development of a watershed model calibrated to recent flood events. This runoff model would be used to analyze flows from different frequency rainfall events. The cost for an updated flow frequency analysis could run as high as $50,000. If the results of this analysis are significantly different than the flows in the FIS, it would require re-running the backwater and flood-routing programs. However, as the models would already be setup, the cost of these additional runs would not be significant.

VII. <u>Conclusions</u>.

It appears that Falls Pond and the described wetland areas potentially have some excess storage capacity to reduce flooding in North Attleboro, and decrease discharges in Attleboro center. However, the flood control storage at Falls Pond is currently seasonal as the pool level is raised from 167.5 ft. NGVD to 173.5 ft. NGVD every April for recreational purposes. If the difference between the summer and winter pools could be utilized for flood storage all year by lowering the pool in anticipation of a flood event, then flood levels in North Attleboro may be reduced. The Keyes Associates hydraulic analysis showed that routing a 100-year storm with one gate fully open from the start of the storm and Falls Pond at an initial pool elevation of 167.5 ft. NGVD produces a 100-year flood elevation of 173.45 ft. NGVD. In comparison, when the gates are closed and the starting pool level is 173.5 ft. NGVD, the 100-year flood elevation is 175.71 ft. NGVD, which is close to the FEMA 100-year elevation of 176.0 ft. NGVD. Therefore the flood storage potential of Falls Pond is significant enough to reduce the 100-year flood at the dam by a couple of feet. This analysis could not evaluate the upstream wetland areas in full due to a lack of available information. More detailed studies are required to determine the exact flood storage capacity of Falls Pond and the wetland areas, and their effects on flood levels in North Attleboro.

# TECHNICAL REPORT – 2

# MANCHESTER POND RESERVOIR

# MANCHESTER POND RESERVOIR

## 1. SUMMARY

Manchester Pond Reservoir is the primary storage facility for Attleboro's water supply system. The city requested the Corps to investigate the benefits of creating a connection to divert flows from Falls Pond to available storage in Manchester Pond Reservoir to reduce flooding in the Tenmile River and increase water supply. This study found that the reservoir has sufficient excess storage capacity at certain times of the year to potentially reduce flood levels in Attleboro and North Attleborough while increasing water supply. However, this flood control storage would be seasonal and unreliable. The most effective way to use a connection between Falls Pond and the reservoir would be to use it as a diversion to Sevenmile River, with storage in Manchester Pond as a side benefit. This would require a study to determine the capacity of the Sevenmile River to accept additional flows, and the effect of the diversion on reducing flood levels in Attleboro and North Attleborough centers. In addition, the effects of the diversion on water quality would have to be considered, as the Falls Pond probably has lower water quality than Manchester Pond Reservoir.

## 2. INTRODUCTION

a. Background. Flooding from the Tenmile River in Attleboro and North Attleborough centers is a persistent problem. Flood flows into Falls Pond backup into North Attleborough center, and high discharges from Falls Pond, combined with flows from intervening drainage areas, flood Attleboro center. Using seasonal excess capacity in Manchester Pond Reservoir to store flood flows has been suggested, in the hope that this would reduce flooding in both city centers and increase water supply. This idea would require constructing a conduit from Falls Pond to the reservoir, and Attleboro requested the Corps to perform a cursory evaluation of this under the Flood Plain Management Services program.

b. Locations. Manchester Pond Reservoir is located near the Massachusetts-Rhode Island border, on Attleboro's west side. It is in the headwaters of Fourmile Brook, and between highways 295 on the north, 123 on the south, 95 on the east, and the North Attleborough boundary on the west (Figure 1). The southern most arm of Falls Pond is about 0.4 miles northwest of Manchester Pond Reservoir. Falls Pond is on the other side of route 295 from the reservoir, and is in the Tenmile River watershed while Manchester Pond Reservoir is in the Sevenmile. However, both rivers join in Seekonk, Massachusetts and are part of the same Tenmile River watershed.

c. Available Data. Available data on Manchester Pond Reservoir includes a May 1980 Phase I Inspection Report prepared under the National Dam Inspection Program. Attleboro provided a record of monthly pool elevations from 1992 through July 2000, excerpts from an October 1999 design report by Camp Dresser & McKee, Inc. (CDM) for spillway modifications, and 3 plans showing reservoir features and dated April 2000.

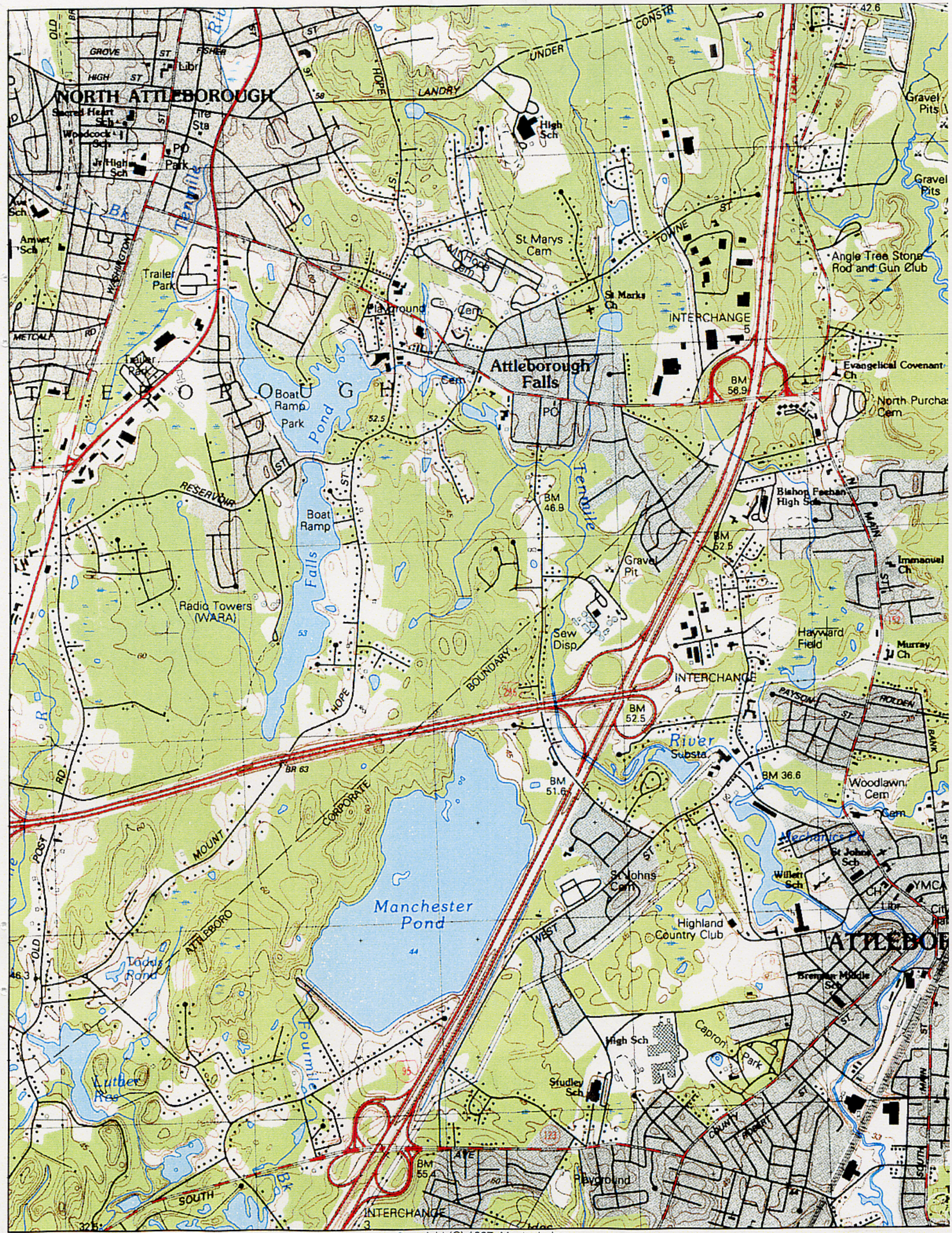

NORTH ATTLEBOROUGH
Attleborough Falls
ATTLEBOR
Manchester Pond
Falls Pond
Boat Ramp
Park
Radio Towers (WARA)
St Marys Cem
Mt Hope Cem
Playground
High Sch
Angle Tree Stone Rod and Gun Club
INTERCHANGE 5
INTERCHANGE 4
INTERCHANGE 3
Evangelical Covenant Ch
North Purchase Cem
Bishop Feehan High Sch
Gravel Pit
Sew Disp
Hayward Field
Murray Ch
Immanuel Ch
Woodlawn Cem
Mechanics Pd
St Johns Sch
St Johns Cem
Highland Country Club
Brennan Middle Sch
Capron Park
Studley Sch
Luther Res
Todds Pond
Trailer Park
Gravel Pits
Tenmile
River
Substa
St Marks Ch
UNDER CONSTR
LANDRY
TOWNE
RESERVOIR
WASHINGTON
METCALF
HOPE
BOUNDARY
CORPORATE
MOUNT
ATTLEBORO
POST
OLD
SOUTH
PAYSON
HOLDEN
BANK
WEST
COUNTY
ROBERT
BM 58.9
BM 46.8
BM 52.5
BM 51.6
BM 55.4
BM 36.6



Figure 1

3. MANCHESTER POND RESERVOIR

a. Features. The dam is an earthen embankment 1510 feet long with a 28-foot maximum height, constructed in 1963. Spillway crest elevation was originally 145 feet, NGVD, but on 15 May 2000, it was raised 1.5 feet to increase water supply storage capacity. Outlet works have inverts at 120 feet, and consist of an 18-inch pipe from the gatehouse to Fourmile Brook and a 48-inch pipe with connections to Luther Reservoir and with a tee directed to the downstream spillway channel. At elevation 145, the pool has an area of 227 acres, which is a little over half its total 448-acre (0.70 square mile) drainage area.

b. Discharge Capacity. With the pool at the top of dam elevation of 150 feet, NGVD, the capacity of the current spillway (elevation 146.5 feet) is about 380 cfs. The estimated combined capacity of the discharge pipes with the pool at spillway crest elevation 146.5 is around 250 cfs.

c. Operation. Pool levels vary seasonally with changes in water supply demand and streamflow. Surplus water is pumped from Luther Reservoir to fill Manchester Pond to spillway crest when possible, and water is withdrawn from Manchester Pond when Luther Reservoir's level drops (Figure 2). Typically the pool at Manchester Pond reaches a peak in March and a minimum in October. The raising of the spillway crest in May 2000 to elevation 146.5 means that more water will be diverted to and stored in Manchester Pond when it is available. With a watershed only about twice the pond's surface area, rainfall runoff volumes from the Manchester Pond watershed are small and the water level seldom exceeds the spillway crest elevation by more than a few tenths of a foot.

d. Reservoir Storage. The CDM report gives the storage capacity as 3280 acre-feet at elevation 145 feet, NGVD and 3620 acre-feet at elevation 146.5 feet. The Phase I inspection report gives the total storage with the pool at the top of dam as 4210 acre-feet. Using contours in the CDM report, storage at elevation 140 was calculated as 2195 acre-feet. Storages below that elevation were estimated by assuming that the 4 acre per foot drop in surface area between elevation 146.5 and 140 continued to elevation 134 feet. Below that elevation, storage was assumed to decrease linearly to zero at elevation 122 feet, NGVD. The resulting estimated stage-storage curve is given in Figure 3.

e. Pool Stages. Attleboro provided a record of monthly pool stages for the period January 1992 through July 2000 (Table 1). Using this table, average and minimum monthly pool levels – excluding months after April 2000 when the spillway and pool level were raised – were calculated and entered into Table 2. Using these numbers, the monthly storage available for flood control was calculated and added to Table 2 in terms of acre-feet and inches of runoff for the 20 square mile drainage area of the Tenmile River at Attleboro center.

f. Available Storage. Table 2 shows that average monthly storage available for flood control ranges from zero in April to 1.3 inches in October, the overall average was

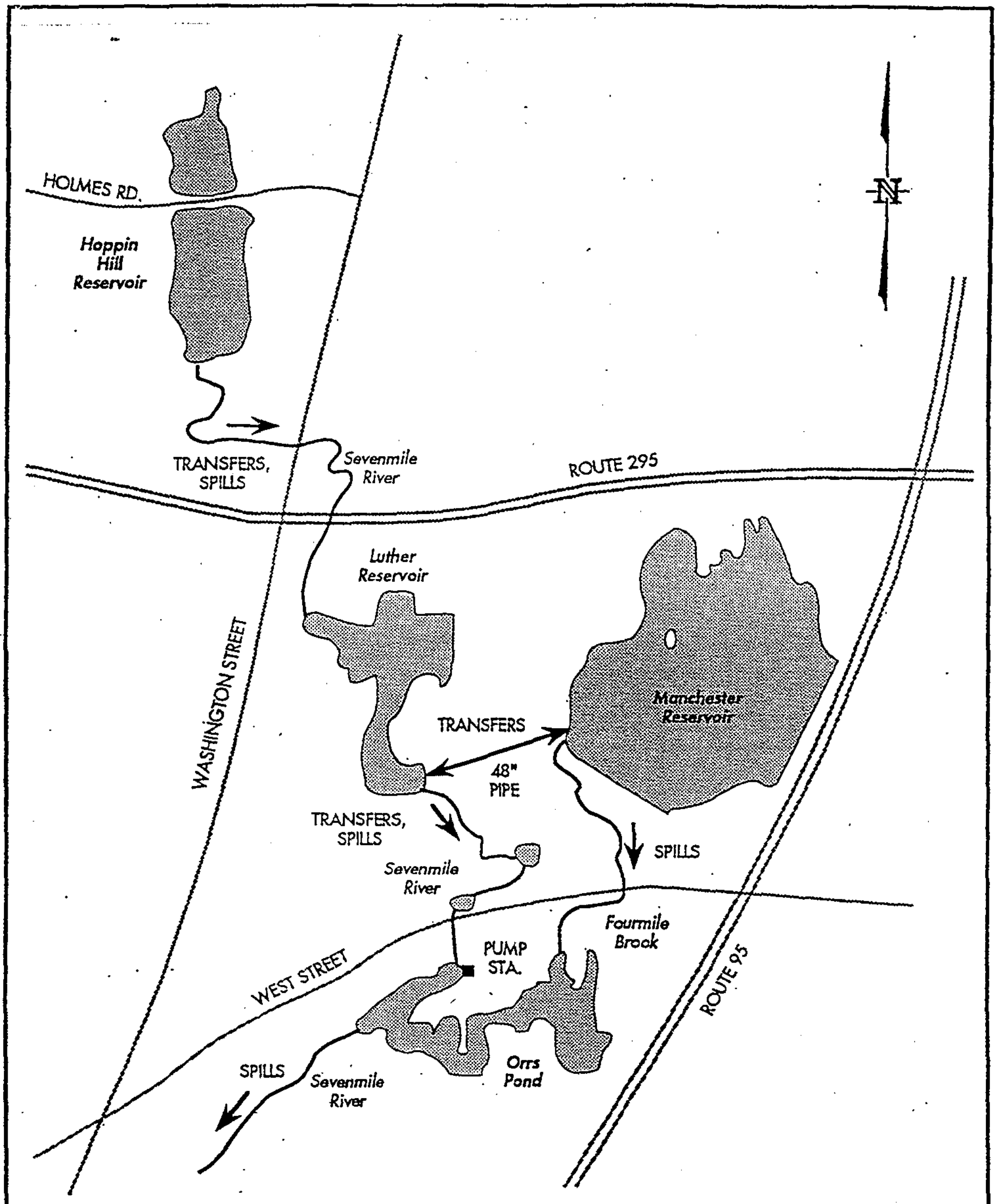
0.6 inches, and the maximum for any individual month was 1.8 inches. Inches of runoff were calculated for the 20 square mile drainage area upstream of County Street in Attleboro, which is about where flooding in Attleboro center begins. Table 2 shows that over an inch of storage is usually available in the late summer, which is enough to produce significant reductions in water levels during some floods, but not enough to solve flooding problems. Furthermore, this storage is unreliable. The minimum storage available in September was equivalent to an inch of runoff, but that was in a period of record of only 8 years, and for most months of the year the minimum storage available for flood control was zero. Furthermore, since floodwaters diverted to the reservoir would be retained for water supply, construction of a diversion from Falls Pond would further reduce the average available storage in Manchester Pond Reservoir.

g. Effects of Change in Spillway Crest Elevation. The raising of the spillway crest from elevation 145 to 146.5 feet, NGVD in May 2000, increased the water supply storage but did not change the total available storage. Manchester Pond Reservoir is filled to spillway crest when surplus water is available in Luther Reservoir, and potential flood control storage would be made available by withdrawals for water supply or discharges to Fourmile Brook. An increase in water supply withdrawals would increase the flood control storage, but by the same amount regardless of the spillway crest elevation, unless the pond was being drawn down completely. Raising the spillway crest means that, when the reservoir is full, the amount of surcharge storage available for flood control is reduced.

h. Rule Curve. Operating to a rule curve would increase the reliability of flood control storage availability at Manchester Pond Reservoir. This rule curve would set maximum elevations for the reservoir for each month and require that water be discharged to Fourmile Brook during months when water supply needs alone were not enough to bring the pool down. Although operating in such a manner would increase the available flood control storage, it would reduce water supply storage. During a prolonged drought, water, that was dumped earlier to make room for floods that didn't materialize, could be sorely missed. Furthermore, the flood control storage would still be seasonal.

## 4. DIVERSIONS

a. Flow Diversions. Diverting water from Falls Pond to excess storage in Manchester Pond Reservoir during floods could reduce flooding in Attleboro and possibly North Attleborough, especially during the more frequent smaller floods. This would also increase water supply; however, the flood control benefits would be seasonal and unreliable. A more effective way to benefit from such a diversion would be to take advantage of capacity in Fourmile Brook and Sevenmile River so that diversions could be made to Manchester Pond Reservoir beyond the amount that could be stored. This would get floodwaters around the damage areas in Attleboro center. Discharges from Manchester Reservoir could be made through the existing outlets or by allowing spillway discharge. Because the spillway is now only 3.5 feet from the top of the dam, it may be desirable to increase the length of the spillway or raise the height of the dam if diverted flows are to




| | |
|---|---|
| City of Attleboro, Massachusetts | **Figure 2** |
| **CDM** *environmental engineers, scientists planners, & management consultants* | SCHEMATIC OF WATER SUPPLY SYSTEM – TEN MILE BASIN |

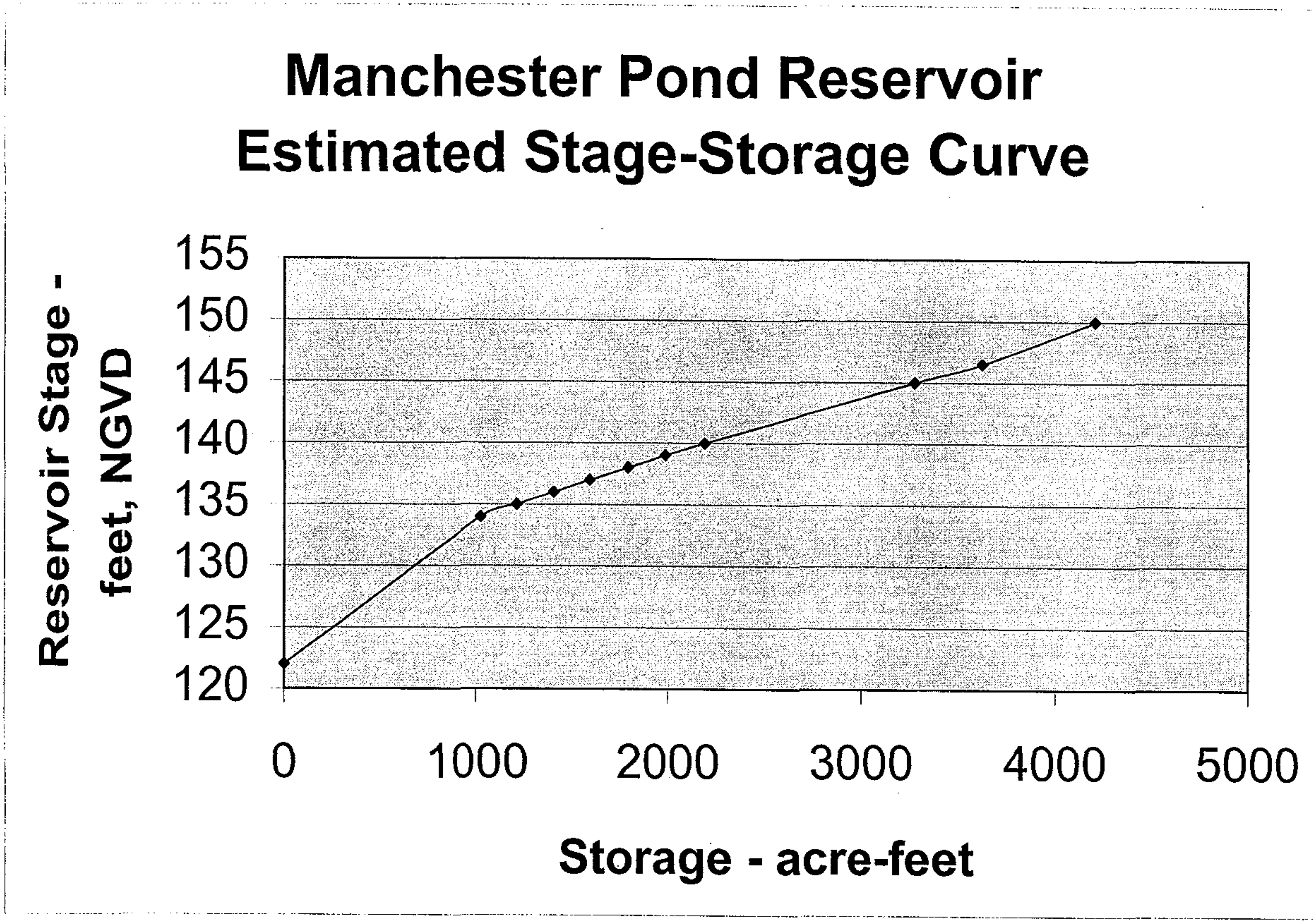

Manchester Pond Reservoir
Estimated Stage-Storage Curve
Reservoir Stage - feet, NGVD
155
150
145
140
135
130
125
120
0
1000
2000
3000
4000
5000
Storage - acre-feet

Figure 3

TABLE 1
Manchester Pond Reservoir Elevations
(feet, NGVD)

| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| Jan | 145.0 | 144.9 | 142.1 | 141.8 | 145.3 | 145.2 | 141.7 | 145.0 | 142.6 |
| Feb | 144.3 | 144.9 | 144.4 | 142.5 | 145.4 | 144.9 | 145.2 | 145.0 | 143.6 |
| Mar | 145.0 | 145.1 | 145.2 | 144.0 | 144.9 | 145.0 | 145.1 | 145.1 | 144.6 |
| Apr | 144.8 | 145.1 | 144.9 | 144.8 | 145.1 | 145.0 | 145.1 | 145.1 | 145.4 |
| May | 144.1 | 144.8 | 144.5 | 144.4 | 145.0 | 144.8 | 144.8 | 144.8 | 146.7* |
| Jun | 143.4 | 142.1 | 142.3 | 145.1 | 143.4 | 142.6 | 145.3 | 141.6 | 145.5 |
| Jul | 141.2 | 139.8 | 140.1 | 141.6 | 142.7 | 139.3 | 143.3 | 139.1 | 143.3 |
| Aug | 140.7 | 138.8 | 139.4 | 138.5 | 140.7 | 137.9 | 142.0 | 138.4 | |
| Sep | 139.6 | 137.2 | 138.4 | 137.3 | 138.4 | 137.1 | 139.9 | 139.0 | |
| Oct | 139.0 | 135.8 | 137.1 | 138.0 | 142.3 | 135.9 | 139.2 | 139.4 | |
| Nov | 141.4 | 136.3 | 137.7 | 141.0 | 143.6 | 137.0 | 139.2 | 140.3 | |
| Dec | 145.0 | 139.8 | 139.2 | 142.0 | 145.1 | 137.5 | 139.0 | 141.2 | |

*Start of 1.5-foot higher spillway crest.

TABLE 2
Manchester Pond Reservoir Monthly Available Storage

| | Monthly Averages | | | Monthly Maximum Storage | | | Monthly Minimum Storage | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Pool Elev. | Available Storage | Available Storage | Monthly Minimum Pools | Available Storage | Available Storage | Monthly Maximum Pools | Available Storage | Available Storage |
| | (ft, NGVD) | (acre-ft) | (inches) | (ft, NGVD) | (acre-ft) | (inches) | (ft, NGVD) | (acre-ft) | (inches) |
| Jan | 143.7 | 290 | 0.3 | 141.7 | 730 | 0.7 | 145.3 | 0 | 0 |
| Feb | 144.5 | 110 | 0.1 | 142.5 | 550 | 0.5 | 145.4 | 0 | 0 |
| Mar | 144.9 | 20 | 0.0 | 144.0 | 220 | 0.2 | 145.2 | 0 | 0 |
| Apr | 145.0 | 0 | 0.0 | 144.8 | 50 | 0.0 | 145.4 | 0 | 0 |
| May | 144.7 | 70 | 0.1 | 144.1 | 200 | 0.2 | 145.0 | 0 | 0 |
| Jun | 143.2 | 400 | 0.4 | 141.6 | 750 | 0.7 | 145.3 | 0 | 0 |
| Jul | 140.9 | 900 | 0.8 | 139.1 | 1270 | 1.2 | 143.3 | 380 | 0.4 |
| Aug | 139.6 | 1170 | 1.1 | 137.9 | 1510 | 1.4 | 142.0 | 660 | 0.6 |
| Sep | 138.4 | 1410 | 1.3 | 137.1 | 1670 | 1.6 | 139.9 | 1110 | 1.0 |
| Oct | 138.3 | 1430 | 1.3 | 135.8 | 1920 | 1.8 | 142.3 | 600 | 0.6 |
| Nov | 139.6 | 1170 | 1.1 | 136.3 | 1820 | 1.7 | 143.6 | 310 | 0.3 |
| Dec | 141.1 | 850 | 0.8 | 137.5 | 1590 | 1.5 | 145.1 | 0 | 0 |
| Average | | 652 | 0.6 | | 1023 | 1.0 | | 255 | 0.2 |
| Max. | | 1430 | 1.3 | | 1920 | 1.8 | Min. | 0 | 0 |

go over the spillway. It might also be necessary to increase the size of bridge openings or other restrictions on Fourmile Brook or Sevenmile River.

b. Flow Quantities. The optimal amount of flow to be diverted from Falls to Manchester Pond would have to be determined through a cost-benefit analysis comparing the construction costs for the diversion against the benefits in reduced flood damages. However, to give a feel for the numbers, the 10-year flow in Attleboro is 450 cfs, according to the Flood Insurance Study (FIS), and a diversion would likely have to carry a significant amount of this flow to be effective. The distance between the closest parts of Falls and Manchester Ponds is about 2,200 feet. A 48-inch diameter pipe (for example) between those points would carry about 175 cfs by gravity with the pools at spillway crest elevations – 173.5 feet for Falls Pond and 146.5 feet for Manchester Pond Reservoir. The estimated discharge capacity of the existing 48-inch line from Manchester Pond Reservoir to Fourmile Brook with the pool at spillway crest is 240 cfs. Flows in the range of 175 to 240 cfs represent 40 to 50 percent of the peak 10-year flow in the damage areas of Attleboro center, and are potentially enough to significantly reduce damages there.

c. Water Quality. While a connection between Falls and Manchester Ponds would increase the quantity of water supply, it would probably decrease its quality. The watershed for Luther and Manchester Pond Reservoirs is mostly sparsely developed and the water quality is probably pretty good. Falls Pond's watershed includes most of the developed areas of North Attleborough center, and urban runoff during storms – which is when the diversions would take place – is likely of poor quality. The water would still be usable for public supply after treatment, but treatment costs would likely rise.

5. ADDITIONAL STUDIES

a. Introduction. Extensive hydraulic and hydrologic studies could be required to determine the flood damage reduction benefits of diversions from Falls Pond to Manchester Pond Reservoir. However, before undertaking them, an initial study should be made to determine the capacity of Fourmile and Sevenmile Brooks to carry additional flows. If they are already at capacity, then it probably is not worth considering a diversion unless it is for water supply with flood control storage as only a side benefit.

b. Initial Studies. The initial evaluation of Fourmile Brook and Sevenmile River should be conducted using a backwater program, such as HEC-RAS, to compute water levels under existing conditions and with the additional diversion flows. This backwater analysis should start where the Sevenmile and Tenmile Rivers converge, because there would be virtually no effects beyond that, and continue to the base of Manchester Pond dam. There are about a dozen bridges or other channel restrictions that would have to be surveyed – if recent data are not available – for input data to the backwater computations. Based on estimates received for similar survey work proposed in the fall of 1999, the cost to hire a private firm to do this work might be around $25,000. The cost of hiring a private firm to perform the backwater computer program runs might be another $20,000.

c. Main Studies. If Fourmile Brook and Sevenmile River have the capacity to carry a significant portion of the 10-year flood at Attleboro center, then studies could proceed to the next phase. The ten-year flood is used as a minimum standard, based on the idea that an action that doesn't have much effect on at least the 10-year levels will not have enough effect to be worth pursuing. The next phase will require flood-routing analyses to determine the effects of diversions on Falls Pond and Manchester Pond Reservoir levels and discharges, and additional backwater analyses to determine the effects of Falls Pond on flood levels in North Attleborough center, and reduced discharges on flood levels in Attleboro. Finally, the flows in the FIS might need to be updated through a flood-frequency analysis to allow an accurate estimate of how often flood-damage benefits would accrue from this diversion.

(1) Backwater Analyses. Backwater analyses would require survey data from Dodgeville Pond Dam upstream to Whiting Pond. Between these two ponds, an estimated 19 locations would need surveying. Surveys would not be needed below Dodgeville Dam unless there were damage areas that also needed evaluation. Based on estimates received for similar survey work proposed in the fall of 1999, the cost to hire a private firm to do this work might be around $45,000. The cost of hiring a private firm to perform the back-water runs, using a program such as HEC-RAS, might be another $35,000.

(2) Flood-Routing Analyses. Flood-routing analyses could probably be performed with existing mapping supplemented with survey data collected for the backwater analyses. The cost of hiring a firm to perform the computer program runs might be $15,000.

(3) Flood Frequency Analysis. An updated flood frequency analysis would be very useful for determining how often benefits would accrue from flow reductions caused by the diversion. However, as there are no USGS gaging stations in the watershed, such an analysis would be difficult, and it might be better to just use the flows from the FIS. If a new flow-frequency analysis was needed, it could require an in-depth review of current land use, and developing a watershed model calibrated to recent flood events. This runoff model would be used to analyze flows from different frequency rainfall events. The cost for an updated flow frequency analysis might be around $50,000. If the results of this analysis are significantly different than the flows in the FIS, it would require rerunning the backwater and flood-routing programs; however, as these programs would already be setup, the cost of these additional runs would not be large.

## 6. CONCLUSIONS

Manchester Pond Reservoir has sufficient excess storage capacity at certain times of the year such that a diversion from Falls Pond could reduce flooding in Attleboro Center. Such a diversion could also reduce flooding in North Attleborough by keeping the level of Falls Pond down, and would increase water supply at Manchester Pond Reservoir. However, the flood control storage at Manchester Pond Reservoir would be seasonal, unreliable, and of minimal value by itself unless the reservoir was operated to a rule curve, but that would decrease water supply storage. The most effective way to use a connection between Falls and Manchester Ponds to reduce flooding would be to use it as a flood control diversion to Sevenmile River, with storage in Manchester Reservoir as a side benefit. This would require a study of the downstream capacity of Fourmile Brook and Sevenmile River, and the effects on flood reductions in Attleboro and North Attleborough. Any plans to divert Falls Pond water to Manchester Reservoir for water supply storage should also include a study of the effects on water quality, as Falls Pond water is likely to be of lower quality.

# TECHNICAL REPORT - 3

# DODGEVILLE DAM

# DODGEVILLE DAM REPORT

Summary. At the request of the city of Attleboro, the Corps examined the potential for reducing flooding in Attleboro center by changing the operation of Dodgeville Dam. Currently there are no formal operation procedures for the dam and flow over the structure fluctuates based on the pool level. The dam is in disrepair and the outlet works appear to be inoperable and in any case have not been used in many years. Attleboro center is only 2 miles upstream from the dam, and it is likely that backwater from the dam increases flood levels in the city's center, and that increasing the discharge from the dam would reduce upstream flood damages. This might be achievable by clearing the spillway and restoring the function of the outlet works, but it also might require nothing less than breaching or complete removal of the dam. Activities that would increase the discharge from the dam would also increase downstream water levels, and a study would have to look at upstream benefits and downstream damages before proceeding with any major actions.

It is unlikely that lowering the Dodgeville Pond pool level without also increasing the discharge from the dam would have much effect on upstream flood levels. Consequently, any recreational or aesthetic benefits that come from maintaining the present Dodgeville Pond are not coming at the expense of flooding in Attleboro center, at least not as long as the present dam is in place.

Background. Dodgeville Dam is located on the Tenmile River about two miles downstream from the center of Attleboro and two and a half miles above the boundary with Seekonk, Massachusetts (see Figure 1). It's an earthen structure constructed in 1900 to supply power to a mill. The dam is in disrepair and currently serves no purpose other than to impound Dodgeville Pond, which may have recreational or aesthetic benefits.

Pertinent Data. Available data on Dodgeville Dam was limited but sufficient to make general conclusions about the effects of the dam on flooding in Attleboro center. The city of Attleboro provided an inspection/evaluation report by the Massachusetts Department of Environmental Management (DEM), Office of Dam Safety on Dodgeville Pond Dam dated March 23, 1998. They also provided a Public Works Department (PWD) topographical map dated April 26, 1964 that covers the pond from the dam almost to the Lamb Street bridge. Finally, they provided a profile of Dodgeville Dam dated March 1965 that was prepared by the Attleboro PWD for installing a sewer line through the dam. The March 1978 Flood Insurance Study (FIS) for Attleboro was located, and various copies of the original cross sections prepared for that study were obtained from the Massachusetts DEM Flood Hazard Management Office. There is no evidence that an inspection report was prepared for Dodgeville Dam under the national program in the 1970's and 1980's, but there is a limited amount information about the dam in the National Inventory of Dams (NID). Lastly, there are digital photographs from a field trip to the dam in December 1999, and the USGS Attleboro quad sheet.

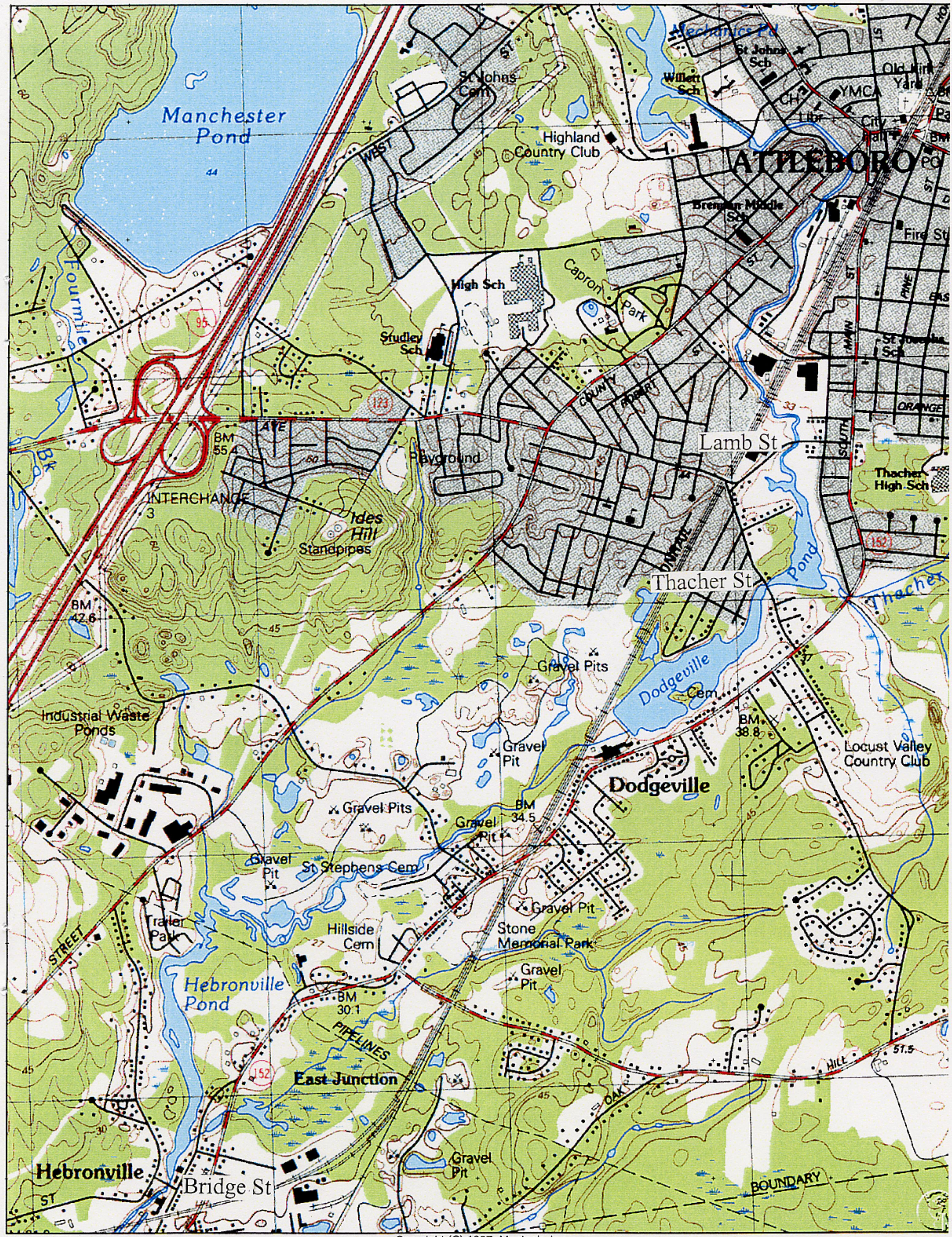

Manchester Pond
Fourmile
Mechanics Pd
St Johns Sch
Willett Sch
St Johns Cem
Highland Country Club
ATTLEBORO
Brennan Middle Sch
YMCA
Old Kirk Yard
City Hall
Fire St
High Sch
Capron Park
Studley Sch
St Josephs Sch
COUNTY
ROBERT
ORANGE
INTERCHANGE 3
BM 55.4
Playground
Lamb St
Thacher High Sch
Ides Hill
Standpipes
Thacher St
Pond
Thacher
BM 42.6
Gravel Pits
Dodgeville
Cem
BM 38.8
Locust Valley Country Club
Industrial Waste Ponds
Gravel Pit
Dodgeville
Gravel Pits
Gravel Pit
BM 34.5
Gravel Pit
St Stephens Cem
Gravel Pit
Trailer Park
STREET
Hillside Cem
Stone Memorial Park
Gravel Pit
Hebronville Pond
BM 30.1
PIPELINES
East Junction
OAK
HILL
Gravel Pit
Hebronville
Bridge St
BOUNDARY
ST



Figure 1

Watershed. The Mass DEM 1998 report gives the drainage area at the dam as approximately 25 square miles. The NID summary sheet gives a drainage area of 18.8 square miles, but this appears to be in error because the FIS study and MassGIS (see Figure 2) give the drainage area at County Street (about two miles upstream from the dam) as 20 and 19.61 square miles, respectively. Neither of those sources gives the drainage area at the dam, but the FIS gives an area of 24 square miles at the Lamb Street bridge, which is at the upper end of Dodgeville Pond. Therefore, the estimate of 25 square miles at the dam is reasonable and sufficiently accurate for the purposes of this report.

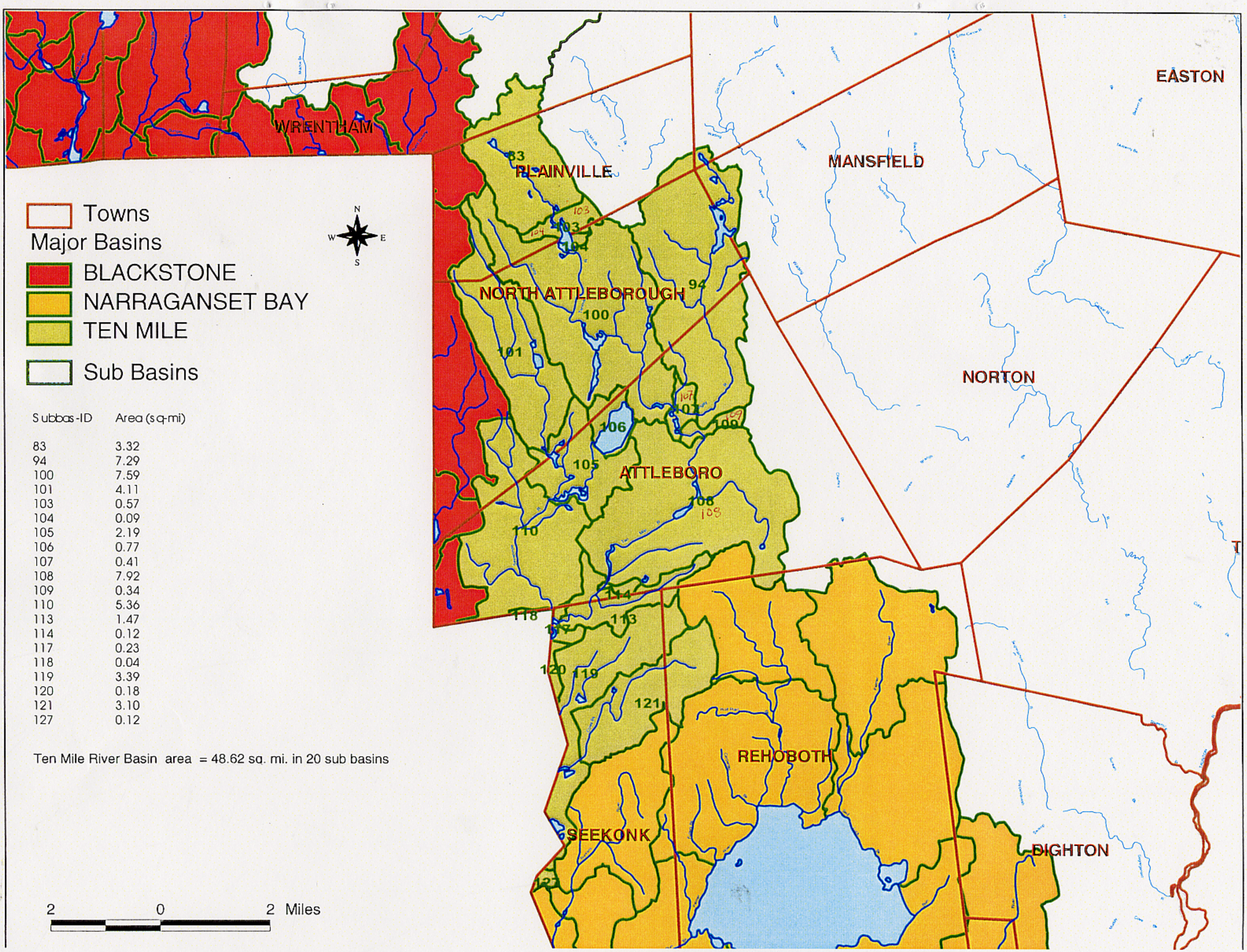
Dodgeville Pond. Dodgeville Pond has two pools separated by a narrow passage at the Thatcher Street bridge. Currently there are no formal operation procedures for the dam or pond, and discharge varies with pool level. The outlet works appear to be inoperable and in any case have not been used in many years. Flow discharges through the spillway, which is partially obstructed by deteriorating stoplogs. Residents living along the edge of Dodgeville Pond report that the "normal pool" level has been dropping over the years, a trend that is likely to continue as the stoplogs deteriorate further.

Surface Areas. Surface areas for Dodgeville Pond at different elevations were scaled from USGS quad sheets and the topo map provided by the Attleboro PWD. Table 1 summarizes these results. The Thatcher Street bridge separates the lower pool from the upper.

Table 1
Dodgeville Dam Surface Areas

| Elevation (feet NGVD) | Lower Pool (acres) | Upper Pool (acres) | Total (acres) |
|---|---|---|---|
| 106 | 28 | 11 | 39 |
| 107 | 52 | 28 | 80 |
| 110 | 64 | | |

Elevations. In order to estimate the magnitude of the effects of lowering the pool on upstream and downstream flood levels, it is necessary to know the height of the dam and its storage capacity at different elevations, i.e. its stage-capacity curve. The height of the dam is 20 to 24 feet, which is enough to potentially affect upstream flood levels, but the data from available sources was incomplete and often contradictory, making it difficult to determine elevations and storage. Table 2 summarizes elevation information from these sources.



WRENTHAM
PLAINVILLE
MANSFIELD
EASTON
NORTH ATTLEBOROUGH
NORTON
ATTLEBORO
REHOBOTH
SEEKONK
DIGHTON
Towns
Major Basins
BLACKSTONE
NARRAGANSET BAY
TEN MILE
Sub Basins
N
S
E
W
83
103
104
94
100
101
106
107
109
105
108
110
114
118
113
117
120
119
121
127
Subbas-ID Area (sq-mi)
83 3.32
94 7.29
100 7.59
101 4.11
103 0.57
104 0.09
105 2.19
106 0.77
107 0.41
108 7.92
109 0.34
110 5.36
113 1.47
114 0.12
117 0.23
118 0.04
119 3.39
120 0.18
121 3.10
127 0.12
Ten Mile River Basin area = 48.62 sq. mi. in 20 sub basins
2 0 2 Miles

| Table 2<br>Dodgeville Dam Elevations<br>(feet, NGVD) | | | | | |
|---|---|---|---|---|---|
| Source | Top of Dam | Spillway | Flashboards | Pool | Invert |
| DEM 1988 | 100.5 | 89.43 | | 91.79 | |
| DEM 1988* | 111.27 | 100.2 | | 102.56 | |
| FIS | 109.9 | 100.2 | 104.6 | 104.1 | 91 |
| PWD Profile | 109.9 | | | 104.8 | |
| PWD Topo | | | | 107 | |
| USGS quad | | | | 106 | |

*DEM 1988 report elevations plus 10.77 feet.

<u>DEM Report Adjustments</u>. Elevations in the 1998 DEM report had to be adjusted, because the report did not relate elevations to NGVD, but used relative elevations based on an assumed 100 foot elevation for a manhole on the right training wall. Profiles of the dam show varying top elevations, and it was not easy to convert the elevations in the DEM report to NGVD for comparison with other sources. The PWD March 1965 profile shows a manhole in what appears to be the right training wall with an elevation of 110.0, which would mean an even 10 feet should be added to the DEM 1998 report elevations. However, the FIS cross-sections show a spillway crest elevation of 100.2, which would mean the 1998 DEM report elevations should be adjusted by adding 10.77 feet. The 10.77-foot correction was used because the FIS was more recent, and the March 1965 profile may not have been an as-built drawing. The FIS profile shows the top of dam elevation varying from 109.9 to 112 feet, so corrections of 10 or 10.77 feet to the DEM elevations could still give agreement with the FIS report.

<u>Reservoir Storage</u>. Storage behind the dam is given in the NID and DEM reports as 275 acre-ft at the top of the dam and 150 acre-ft at the normal pool level. It seems likely the DEM report got its numbers from the NID summary, and the storage at "normal pool" does not necessarily relate to the pool level recorded during their inspection. It also appears that the 275 acre-feet of storage at the top of the dam applies only to the lower part of Dodgeville Pond – downstream of the Thatcher Street bridge and east of the railroad tracks. The volume between the 110 and 106-foot contours for the lower pond is 156 acre-feet, which leaves a storage of 119 acre-feet below elevation 106. However, the NID and DEM reports give the "normal pool" storage as 150 acre-feet. This indicates that the storage at the top of dam may be greater than 275 acre-feet, or the "normal pool" level may not be elevation 106 feet. It also shows that the storage in the pond upstream from Thatcher Street, which has a surface area of 11 acres at elevation 106, must not be included in the 275 acre-feet. This also means that the normal pool storage of 150 acre-feet does not include areas upstream of the Thatcher Street bridge.

<u>Normal Pool Elevation</u>. The NID and DEM reports give a storage of 150 acre-feet at normal pool elevation, but it is not clear what that elevation was. Each source in Table 2 shows a different pool level, which in some cases may have been the elevation on the day

of the inspection, and in other cases may have been an estimation of the normal pool. The NID's normal pool may have been the 106 feet, NGVD given on the USGS quad, or the 104.1 feet observed on the day of the FIS inspection. Flashboards on that day were set at three different elevations ranging from 102.1 to 103.6 to 104.6 ft; therefore, an assumed "normal pool" of 104.1 would be reasonable. The current normal pool elevation is likely lower due to deterioration of the flashboards; the DEM report states that residents around the pond have noticed the pool level dropping in recent years.

<u>Top of Dam Elevation</u>. The FIS profile shows the top of dam elevation varying from 109.9 to 112 feet, NGVD. For this report, the "top of dam" was taken as the elevation at which it could first be overtopped - 109.9 feet.

<u>Invert Elevation</u>. The bottom of the pond was estimated from a profile in the FIS report profile to be 91 feet, NGVD.

<u>Draining the Pool</u>. The maximum benefit that could be obtained from lowering the pool would occur if it was drawn down completely. Storage at the "normal pool" level is given as 150 acre-feet. While it is not certain what elevation this applies to, with the deterioration of the stoplogs it is unlikely that it is any lower than the current normal pool. Therefore, the increase in storage obtained by draining the pool can't be more than 150 acre-feet. This number applies only to the storage in the lower pool. While there is not enough information to estimate the storage in the upper pool (between Thatcher and Lamb Streets), it is highly unlikely to be more than that in the lower pool, because the lower pool is deeper and has more surface area. Therefore, the maximum increase in storage from draining the upper pool would be another 150 acre-feet making the total increase in storage from draining all of Dodgeville Pond not more than 300 acre-feet and probably significantly less. Spread over a 25 square-mile drainage area, 300 acre-feet of storage is equivalent to only about 0.2 inches of runoff.

<u>Effects of a Lower Pool</u>. It is difficult to relate a change in downstream storage to a reduction in upstream water levels without a more detailed study. However, the small amount of storage behind the Dodgeville Pond Dam means that even if the pond were drawn completely down, it would not be enough to have much effect on upstream flood levels. A runoff volume of 0.2 inches can occur very easily at the beginning of a flood event, resulting in filling Dodgeville Pond before the arrival of the peak flow. When this happens, and it is very likely to occur in this watershed whose large areas of natural storage will delay the arrival of the peak flow, there would be no reduction in flood levels upstream from the pond. This also means that any aesthetic or recreational benefits accruing from maintaining the present Dodgeville Pond are not coming at the expense of flood damages in Attleboro center, at least not as long as the present dam is in place.

<u>Increasing Dam Discharges</u>. While lowering the pool would not reduce upstream flooding much, increasing the discharge through the dam might make a significant difference. The FIS for Attleboro shows the water level for the 10-year flood rising 12.5 feet at the dam, indicating that the dam is a significant restriction to flow, and that reducing this restriction could significantly lower upstream flood levels, provided other

hydraulic restrictions – such as restrictive bridge openings – are not present. Ways to accomplish this range from clearing the flashboards and their supports from the spillway, to reactivating and enlarging the outlet gates, to breaching or even removing the dam. The maximum benefit to upstream flood levels, while still retaining Dodgeville Pond for recreation or other reasons, would be achieved by greatly increasing the spillway capacity so a pool is maintained but higher flows cause minimal increases in pool levels. Any of these actions would lower flood levels in Attleboro center, but it would require a back-water analysis to determine how much benefit would be achieved. It may also be necessary to increase the size of upstream bridge openings to get the full benefits from changes at the dam.

Loss of Storage from Dam Removal. The NID summary gives the total storage at the top of the dam as 275 acre-feet. However, this apparently is only the storage in the lower pool between the dam and Thatcher Street. Still, the maximum storage lost if the dam were removed would not be more than twice the 275 acre-feet in the lower pool or 550 acre-feet, which is equivalent to only about 0.4 inches of runoff from the 25 square-mile watershed. However, the effective loss of storage would be that between the normal pool and the top of dam, and would be equivalent to only 0.2 to 0.3 inches of runoff.

Downstream Effects. Changes that reduce the storage and increase the discharge from the dam would increase downstream flows with the potential to create or aggravate downstream flooding problems. The loss of such a small amount of storage would not cause problems for downstream areas unless they are already being flooded fairly frequently. There would need to be discussions with the town of Seekonk, Massachusetts and the city of Pawtucket, Rhode Island to determine if they have areas along the Tenmile River that might be affected by a loss of storage at Dodgeville Dam. Computer modeling of these areas would then be required to determine the change in flood levels with changes at the dam. It is unlikely the effects would extend beyond the Bridge Street bridge, as wetland areas between the Bridge and Tiffany Street bridges would likely absorb the extra discharges and prevent further increases in downstream flood levels. Therefore, computer simulations would probably not have to extend below Bridge Street. However, if it was found that downstream levels were being increased, flood mitigation measures would likely be required.

Computer Simulations. A backwater analyses using the HEC-RAS program would be needed to determine the effects of changes at the dam on upstream and downstream flood levels. This analysis would require recent survey data at restrictions in the river cross section, before the actual computer program could be run. Benefits from increasing the discharge at Dodgeville Dam would not likely extend upstream beyond Mechanics Pond dam or downstream beyond Bridge Street, so the surveys and backwater analyses would not need to go further than those locations. A flood flow analysis using HEC-HMS would be required to analyze downstream effects, but could likely use the survey data collected for the backwater analysis.

Surveys. The computer simulations would require surveyed cross sections at a minimum of 14 locations; the need for a few more survey cross sections might become apparent during the study. Locations where surveys would be required, from downstream to upstream, are

Bridge Street bridge
Tiffany Street bridge
Conrail bridge
Dodgeville Dam
Thatcher Street bridge
Lamb Street bridge
Conrail bridge
Olive Street bridge
Wall Street bridge
County Street bridge
Hodges Street bridge
Mechanic Street bridge
Bridge at road east of Nordic Building
Mechanics Pond Dam

At each bridge, cross sections should be surveyed of the upstream and downstream channels, and measurements of bridge openings, top of road elevations, pier widths and shapes, and low chord elevations should be made. At each dam, one cross-section including measurement of dam length, width, spillway/weir and crest elevations should be made. Cross sections should extend horizontally on each side of the river a sufficient distance to reach an elevation of about ten feet above the channel invert. Survey elevations need to be related to NGVD so they will be on a common datum.

Costs. Based on estimates received for similar survey work proposed in the fall of 1999, the cost to hire a private firm to do this work would be about $30,000. The cost of performing the HEC-RAS and HEC-HMS computer program runs to determine the effects of these changes might be another $30,000. A separate study would be required to determine the cost of renovating the outlet works, enlarging the spillway, or removing the dam; such a study could likely be performed for $50,000.

Conclusions: It is difficult to relate a change in downstream storage to upstream water levels; however, the small amount of storage behind the Dodgeville Pond Dam means that even if the pond were drawn completely down it would not have much effect on upstream flood levels. While lowering the pool would not have much effect, increasing the discharge through the dam might have significant effects on reducing upstream flooding. Ways to accomplish this range from clearing the flashboards and their supports from the spillway, to reactivating and enlarging the outlet gates, to removing the dam. Any of these would lower flood levels in Attleboro center at least some amount, but it would require a backwater analysis to determine how much benefit would be achieved. Removing the dam would have the most effect, but would also do the most to increase downstream water levels, and computer simulations will have to be performed to evaluate these.